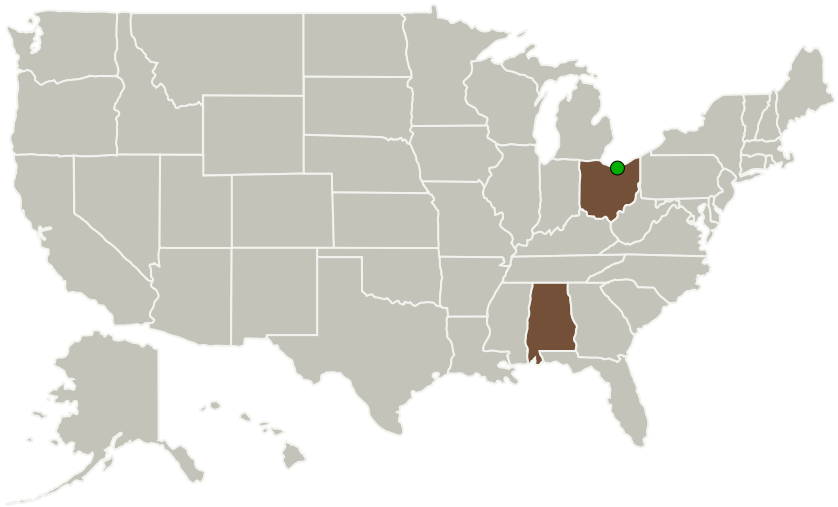
Joining of Tungsten Cermet Nuclear Fuel, Phase I

Completed Technology Project (2016 - 2016)

Project Introduction

Nuclear Thermal Propulsion (NTP) has been identified as a critical technology needed for human missions to Mars due to its increased specific impulse (Isp) as compared to traditional chemical propulsion systems. A critical aspect of the program is to develop a robust, stable nuclear fuel. One of the nuclear fuel configurations currently being evaluated is a cermet-based material comprised of uranium dioxide (UO2) particles encased in a tungsten matrix (W). Recently, hot isostatic pressure (HIP) and spark plasma sintering (SPS) processing techniques have been evaluated for producing W cermet-based fuel elements from powder feedstocks. Although both techniques have been used successfully to produce W cermet fuel segments, the fabrication of full-size W cermet elements (>20) has proven to be difficult. As a result, the use of W cermet segments to produce a full-size W cermet fuel element is of interest. However, techniques for joining the segments are needed that will not lower the use temperature, damage the UO2 particles, or compromise the nuclear performance of the fuel. For these reasons, joining of the segments using braze or weld techniques is not desired. Therefore, diffusion bonding techniques will be developed during this investigation for producing full-size nuclear fuel rods from W cermet segments. To promote diffusion during solid state bonding, different refractory metal interfacial coatings will be evaluated.

Primary U.S. Work Locations and Key Partners



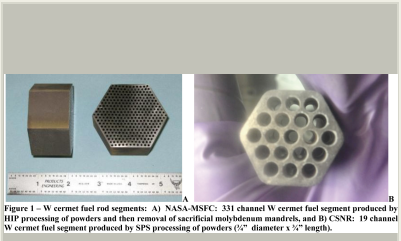


Figure 1 – W cermet fuel rod segments: A) NASA-MSFC: 331 channel W cermet fuel segment produced by HIP processing of powders and then removal of sacrificial molybdenum mandrels, and B) CSNR: 19 channel W cermet fuel segment produced by SPS processing of powders (½" diameter x ¾" length).

Joining of Tungsten Cermet Nuclear Fuel, Phase I

Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Small Business Innovation Research/Small Business Tech Transfer

Joining of Tungsten Cermet Nuclear Fuel, Phase I

Completed Technology Project (2016 - 2016)

Organizations Performing Work	Role	Type	Location
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Alabama	Ohio

Project Transitions

June 2016: Project Start

December 2016: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/139797)*

Images

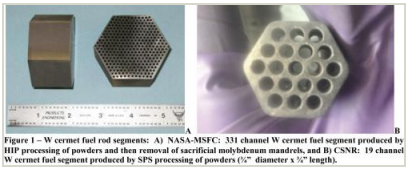
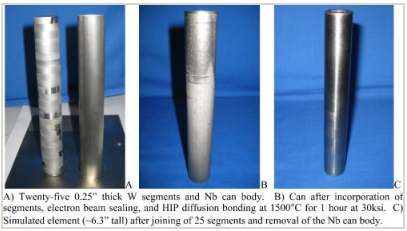


Figure 1 – W cermet fuel rod segments: A) NASA-MSFC: 331 channel W cermet fuel segment produced by HIP processing of powders and then removal of sacrificial molybdenum mandrels, and B) CSNR: 19 channel W cermet fuel segment produced by SPS processing of powders (¼" diameter x ¼" length).

Briefing Chart Image
Joining of Tungsten Cermet Nuclear Fuel, Phase I
(https://techport.nasa.gov/image/128197)



A) Twenty-five 0.25" thick W segments and Nb can body. B) Can after incorporation of segments, electron beam sealing, and HIP diffusion bonding at 1500°C for 1 hour at 30ksi. C) Simulated element (~6.3" tall) after joining of 25 segments and removal of the Nb can body.

Final Summary Chart Image
Joining of Tungsten Cermet Nuclear Fuel, Phase I Project Image
(https://techport.nasa.gov/image/129878)

Project Management

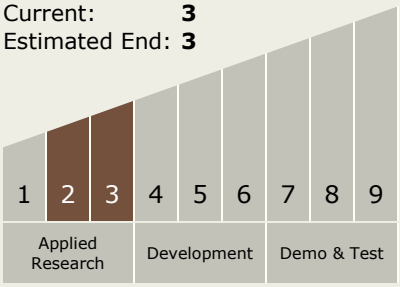
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
John Scott S O'dell

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.4 Advanced Propulsion
    - TX01.4.3 Nuclear Thermal Propulsion

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System